

Walker W

State Department of Agriculture

State Capitol, Madison, Wisconsin

John D. Jones, Jr., Commissioner

Bulletin No. 68

May 1925



BLACK STEM RUST
and the progress of
BARBERRY ERADICATION
in Wisconsin

SUMMARY

Black stem rust has caused heavy losses of all grains in the north central part of the United States. The common barberry is the important factor in the spread of this disease in this section. Stem rust appears on grains or grasses near infected barberry bushes earlier than on the grains or grasses which are some distance from the bushes.

In Wisconsin, 3,372,783 barberry bushes and 1,222,154 seedlings have been found on 9,561 properties, the majority of which are scattered in the sections farmed most intensively throughout the state.

The number of escaped barberries has been rapidly increasing. By checking their spread additional losses of small grains have been prevented.

The cost of the barberry eradication program to date has been less than 3 cents per acre of small grains raised in the state in a single year.

A second survey is necessary in a number of counties to locate missed bushes and recheck the properties on which bushes have been located to prevent the development of sprouts and seedlings.

Every citizen can aid in the campaign by advising the State Entomologist, Madison, Wisconsin, of the location of any bush which is suspected of being a common barberry.

BLACK STEM RUST AND THE PROGRESS OF BARBERRY ERADICATION IN WISCONSIN

By WM. A. WALKER, *Assistant Pathologist*, and NOEL F. THOMPSON, *Associate Pathologist*, United States Department of Agriculture.^a

BLACK STEM RUST

STEM RUST LOSSES ARE HEAVY

Black stem rust is the most destructive disease of oats, barley, rye and wheat in Wisconsin and the neighboring north central states. The annual loss from this source is very large, and in years of destructive heavy epidemics, it is enormous. It is estimated to have averaged over 48,000,000 bushels per year for all small grains in the thirteen north central grain-growing states for the 10 years 1915 to 1924, inclusive. Wisconsin's share of this average annual loss during this period was over 1,000,000 bushels. In the United States the yearly reduction of wheat alone has varied from 800,000 bushels, as estimated for 1918, to the enormous loss of over 180,000,000 bushels as estimated for 1916.

Wisconsin produces annually about 90,000,000 bushels of oats, 20,000,000 bushels of rye and barley, and 2,000,000 bushels of wheat. The yields of these crops are reduced by general and local epidemics of stem rust. The largest stem rust loss in wheat estimated for Wisconsin was 2,208,000 bushels in 1920. Stem rust losses of oats reached about 1,000,000 bushels in each of the years 1917, 1922 and 1924. The largest loss of barley was 720,000 bushels in 1919. The losses of rye have been small except in very local areas. However, in 1920 the losses due to stem rust reached a total of 324,000 bushels. For this reason, Wisconsin is vitally interested in uniting with the other north central, grain growing States to control this disease.

^aThe Barberry Eradication work in Wisconsin is conducted jointly by the Wisconsin Department of Agriculture, the Agricultural Extension Service of the University of Wisconsin, and the Office of Cereal Investigations of the United States Department of Agriculture. The writers wish to acknowledge the assistance of Dr. S. B. Fracker, State Entomologist, in writing this bulletin.

STEM RUST IS A TINY PLANT

The stem rust organism is a fungus or tiny plant which obtains its food from the grain plant. It multiplies rapidly under favorable weather conditions. In forming its spores, stem



Fig. 1.—Black or teleutospore stage of rust on stems of rye and the comparison of heads and kernels from infected and healthy plants.

rust steals the plant food which should be used in producing the plump kernels of grain. It also causes the loss of moisture through the rust pustules. As a result the yield is less, often a total loss, and the quality of the grain is reduced.

STEM RUST LIVES ON THE COMMON BARBERRY IN THE SPRING

In order to live from year to year in the northern and central parts of the United States, the stem rust fungus must live a part of the year on the harmful barberry bush (Cover Illustration) and the balance of the year on one of the small grains or wild grasses, which are susceptible to it.



Fig. 2—Escaped barberry bush treated with salt.

During the winter, pustules containing black spores may be found on grain stubble and wild grasses which have been attacked by stem rust the previous summer. In the spring these winter spores produce other spores which can develop only when they fall on the leaves of the common barberry. There they produce clusters of small cups containing yellow spores which are carried by the wind to grains and grasses.

The rust spores from the barberry germinate on the young grain in May and June and produce pustules of red spores. The latter in turn are blown to other grain plants, and the rust spreads throughout the summer in this way. As the grain ripens, black spores are produced on the same grain plants on which the red spores were previously formed. (Fig. 1) This again is the stage that passes the winter on the stubble. The red spores produced on the grain in summer and the yellow spores on the barberry in the spring are the only ones which can start rust directly on grain.

Investigations have been made during the last few years to determine whether or not the red stage of stem rust on the fall-sown grains is capable of overwintering and causing rust in the



Fig. 3—Japanese barberry—harmless.

spring without the aid of the barberry. Practically all red spores perish early in the winter. The remainder are killed by the freezing and thawing weather throughout the late winter

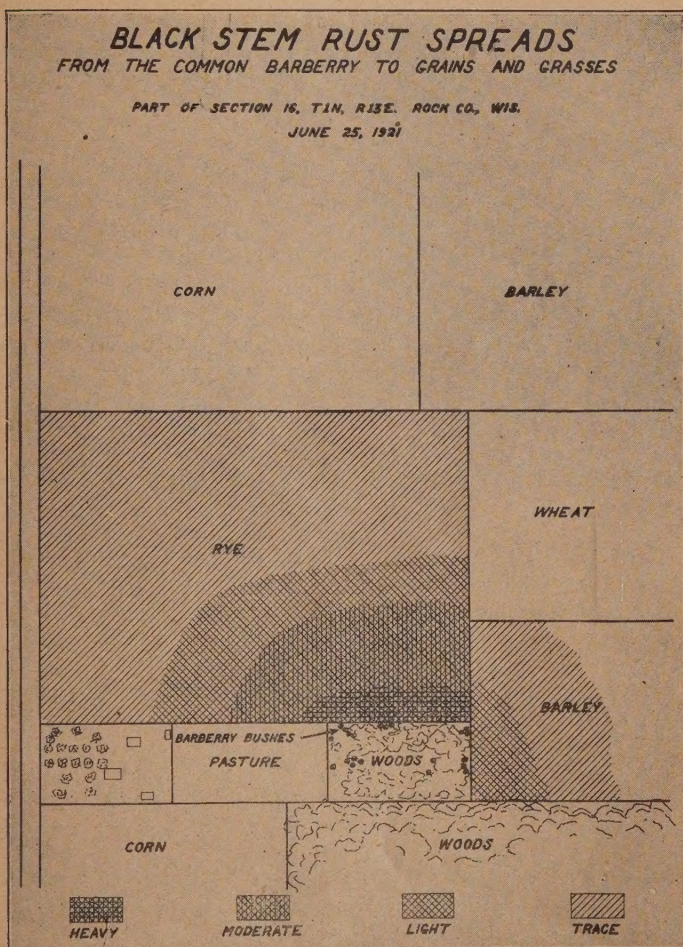


Fig. 4.—SPREAD OF RUST FROM THE BARBERRY

Map showing the spread of black stem rust from common barberry bushes growing wild in a pasture and woodlot in Rock County, Wisconsin, in 1921. The density of shading shows the severity of the rust infection on rye and barley. Notice that the wheat was not rusted, indicating that only the rye-barley strain of rust was present.

and early spring. In only one or two instances among thousands of observations extending over several years, have red spores been observed to live through the winter under natural conditions in the northern part of the United States. Throughout the season only a very slow and limited development of stem rust occurred near this limited source of infection and the spread was over a distance of only a few feet, while the abundant inoculum spreading from barberries produced heavy infection over large areas.

It is impossible for the stem rust fungus to live on the threshed kernels of grain and be carried over from one year to another on the seed as do the smuts of oats. Experiments have shown that none of the rusts are capable of doing this.

Since the common barberry and its horticultural varieties are the only plants which have ever been observed to harbor the spring stage of black stem rust, it is evident that the eradication of these barberries will control the black stem rust of small grains.

HOT DAMP WEATHER FAVORS THE SPREAD OF STEM RUST ON GRAINS

The rapidity of the spread of the red summer spores is affected greatly by weather conditions. Hot, damp weather is ideal for their growth. Moisture is needed for the spores to germinate, and when accompanied by warm weather a rapid reproduction occurs. Heavy dews are sufficient to germinate the red spores, but cool weather or very hot, dry weather will retard their spread.

EVIDENCE AGAINST THE BARBERRY IN WISCONSIN IS CLEAR

Repeated evidences of stem rust outbreaks from barberry bushes have been found in Wisconsin during the survey. The first infections on grain in Wisconsin in the spring have always been found near barberry bushes. The dates of the first infections observed on barberries and on grains are given in Table 1.

TABLE 1.—DATES OF THE FIRST APPEARANCE OF STEM RUST ON BARBERRIES AND ON GRAINS IN WISCONSIN IN THE YEARS 1918 TO 1925, INCLUSIVE.

Season	Rust first observed on barberries	Rust first observed on grain
1918	May 11	June 6
1919	May 18	June 10
1920	May 23	June 12
1921	May 1	May 30
1922	April 29	June 2
1923	April 29	June 14
1924	April 29	June 13
1925	April 27	June 8

Figure 5 illustrates a spread of rust in Waushara County, Wisconsin, from a barberry to a six-acre field of oats and the rapidity with which the spread took place. On July 10, 1923, only a light attack of stem rust was found on the oats near each

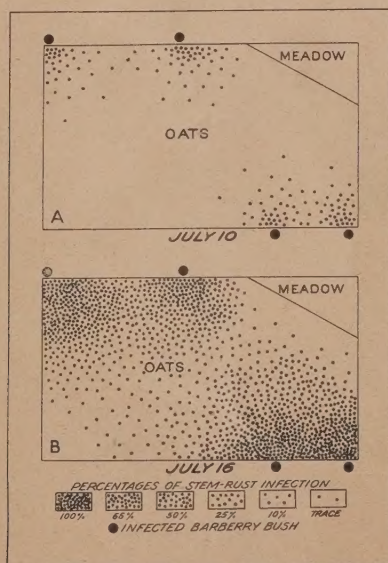


Fig. 5—A. Development and spread of stem rust of oats from nearby barberry bushes, July 10, 1923. B. The same, six days later.

of the four barberry bushes. On July 17, 1923, the stem rust had become heavier and spread to the middle of the field.

The locations of a few of the other outbreaks of stem rust which have been noticed in the state are listed in Table 2. Two typical cases of spread from barberries are shown in Figures 4 and 6.

There are numerous other locations on record, all of which have been found incidentally while carrying on the survey for barberries. In the list of spreads of stem rust, in many cases, the rusted grains and grasses were found first and the barberries were located near where the rust was most severe. Generally the rust pustules are found to be on the side of the grain stem which is toward the barberry bush from which the rust had spread.

BLACK STEM RUST

11

TABLE 2. DATES OF STEM RUST SPREADS FROM COMMON BAR-BERRIES TO SUSCEPTIBLE GRAINS AND GRASSES, WISCONSIN, 1920 to 1924, INCLUSIVE.

Date Observed	County	Township	Grains or Grasses
1920			
July 26	Kenosha	Brighton	Wheat
July 27	Kenosha	Salem	Oats
Aug. 2	Racine	Caledonia	Oats
Aug. 4	Racine	Mt. Pleasant	Wheat
Aug. 5	Racine	Mt. Pleasant	Wheat
1921			
June 17	Rock	Beloit	Rye
June 18	Green	Albany	Oats
June 25	Rock	Turtle	Oats
July 13	Green	Clarno	Oats
July 15	Green	Monroe	Oats
July 16	Dane	Montrose	Oats
1922			
June 16	Lafayette	South Wayne	Oats
June 25	Dane	Black Earth	Oats
June 29	Iowa	Eden	Barley, oats, rye
July 1	Dane	York	Oats
July 11	Grant	Platteville	Oats
July 22	Crawford	Mt. Sterling	Redtop, quackgrass
1923			
June 10	Waushara	Aurora	Rye, oats, redtop
June 25	Dane	Black Earth	Oats, barley, redtop
June 30	Ozaukee	Saukville	Rye
July 30	Winnebago	Oshkosh	Oats
July 31	Winnebago	Oshkosh	Oats
July 31	Winnebago	Neeah	Oats
Aug. 1	Winnebago	Allenville	Oats, barley
Aug. 4	Winnebago	Larson	Oats, wheat
1924			
June 18	Walworth	Darien	Rye, wild barley
June 25	Walworth	Delavan	Quack grass
July 1	Walworth	Geneva	Quack grass
July 2	Dane	York	Oats
July 2	Waushara	Aurora	Italian wild rye
July 3	Dodge	Ashippum	Oats
July 3	Dodge	Ashippum	Barley
July 3	Dunn	Lucas	Oats
July 7	Dodge	Rubicon	Volunteer rye, quack gr.
July 8	Marathon	Marathon	Wheat
July 8	Taylor	Holway	Quack grass
July 11	Dodge	Rubicon	Wheat
July 14	Dodge	Williamstown	Wheat
July 17	Dodge	Rubicon	Oats
July 18	Trempealeau	Trempealeau	Wheat, oats
July 21	Marathon	Wausau	Wheat
July 21	Dane	Mazomanie	Rye
July 29	Forest	Argonne	Quack grass
July 29	Waushara	Aurora	Oats, quack grass, redtop

THERE ARE SEVERAL STRAINS OF STEM RUST

In many instances a field of one kind of grain near an infected barberry is heavily rusted, while an adjoining field of another grain is entirely free of stem rust. This is because of the various strains of stem rust each of which will attack only certain grains and grasses. There is one strain which attacks oats, another one which attacks wheat and barley, another one which attacks rye and barley, one which attacks timothy, one which attacks redtop, and still another which attacks blue grass. All of these different forms can infect many wild grasses, but not all attack the same grasses. Barley is the only grain which is heavily injured by more than one of these strains of stem rust. The fields of wheat shown in both Figures 4 and 6 were entirely free of stem rust because of the absence of the wheat strain. In the field shown in Figure 4 it is quite evident that the rye strain is the one present on the barley, as both rye and barley were rusted and the wheat was not. In the field shown in Figure 6 only the oat strain of stem rust is present.

BARBERRY SPREADS ONLY BLACK STEM RUST

The common barberry carries and spreads stem rust only. There are several other rusts occurring on cereals which are often confused with stem rust. Leaf rust of wheat occurs on the leaves and leaf sheaths but not on the stems. The pustules are bright yellow early in the season and greyish black later on. This disease appears earlier than stem rust, but only very rarely causes severe damage to grain.

Crown rust of oats often causes heavy damage in local areas. The black winter spores of this rust cause infection on the buckthorn bush (*Rhamnus sp.*), which is quite plentiful in Wisconsin. Spores produced on the buckthorn are then blown to the leaves and leaf sheaths of oats, forming concentric rings and pustules containing yellow spores. The pustules are beneath the surface of the oat leaves, while the stem rust pustules cause the epidermis to rupture.

Oat smut is often confused with stem rust. This fungus is evident in the heads only, and replaces the kernel with masses

of black spores. This disease is controlled by treating the seed oats with hot water or formaldehyde.

These diseases have no relation to the barberry.

BARBERRY ERADICATION IS THE ONLY CONTROL FOR STEM RUST IN WISCONSIN

Investigations have been made to find a more simple method of controlling stem rust losses than the eradication of the barberries. However, treatments such as spraying and seed disin-

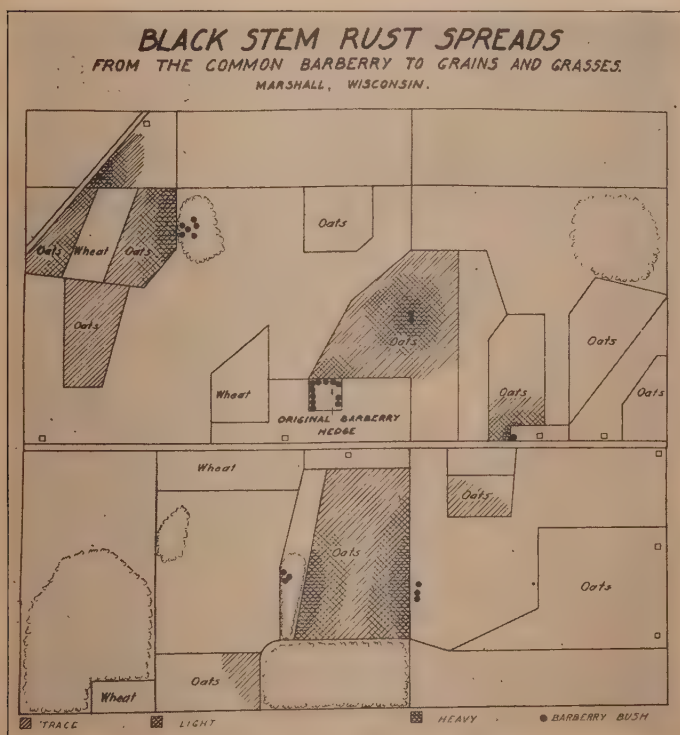


Fig. 6.—SPREAD OF RUST FROM THE BARBERRY

Barberries were scattered by birds and cattle from the hedge shown near the center of the map to nearby woodlots and fence rows. The map illustrates how the rust had spread from these escaped barberries to the grain by July 1, 1922. Notice that the wheat was not rusted, indicating that only the oat strain of the rust was present.

fection which have been successful with other diseases are useless in controlling stem rust.

The breeding of varieties of grain resistant to stem rust has been carried on for many years. This investigation shows promise of developing some varieties highly resistant to stem rust, however, no immediate relief from the great losses caused by this disease can be expected. Although this method of attack is very successful in combating some other plant diseases, many complicating factors have prevented the successful development of grains resistant to rusts.

Some strains of wheat have been found to be resistant to stem rust in some sections of the country, but when sown in other sections they are very susceptible. The most desirable wheats for milling purposes are generally susceptible to stem rust and when resistant strains have been obtained from these, the excellent milling qualities are sacrificed.

The eradication of the barberry has proved successful in European countries. It has proven equally successful in areas cleared of barberries in Ohio, Indiana, and Illinois. It now appears that complete eradication of all rust susceptible barberries from the upper Mississippi Valley will materially reduce the losses resulting from stem rust in this entire area.

THE COMMON BARBERRY

The Common Barberry Is Easily Identified

The common barberry (Fig. 2), which is the spreader of stem rust, is a tall, erect shrub which may reach a height of 12 to 15 or more feet. The leaves have bristle toothed edges and may be green or purple. The red berries are produced in bunches like currants, and the thorns are generally in groups of threes, although single thorns may be present at the tip of the stalk and more than three thorns may be found on the extreme lower part of the stalk. In Wisconsin, the bush usually blossoms in May, having bright yellow flowers. The bark is gray. The roots and the wood beneath the bark in the stalks are a bright canary yellow.

The Japanese barberry, (Fig. 3), which is not susceptible to black stem rust, is a small shrub seldom reaching a height of more than 4 feet. It has small, smooth-edged leaves, and usually

its thorns are single. The red berries are produced singly or in pairs. This kind is easily distinguished from the common barberry and, as it can not spread stem rust, it should be used for decorative purposes as in the past. Hybrids between the common and Japanese barberry quite often are found rusted. These hybrids should be destroyed.

The Common Barberry Came From Asia

The common barberry is native neither to Wisconsin nor the United States, but is believed to have come originally from western Asia. One of the earliest records of the plant is in the Babylonian writings of about 650 B.C., where it is mentioned as being of medicinal value. Like many other Asiatic medicinal plants, it was carried by man wherever civilization advanced, and probably was introduced into every settlement and village of Europe in this way. Its berries were used in making beverages, jellies, and preserves. It also became popular as a hedge to separate fields.

Barberry Was Introduced by Early Settlers

The barberry was one of the first plants to be introduced into the United States. It was well established in the American colonies by the end of the seventeenth century.

Many plantings were set out in Wisconsin early in the nineteenth century. Practically all of these were introduced by New England settlers or by early settlers coming directly from various parts of Europe. Later, thousands of common barberries were purchased from nurseries until 1918, when the barberry eradication campaign was begun.

THE BARBERRY ERADICATION CAMPAIGN

European Countries Have Eradicated Barberries

There are records of people who, early in the seventeenth century realized that their yields of grain were greatly reduced by the presence of nearby barberries. Heavy local losses from stem rust caused laws to be passed years ago in European countries and by some of the American colonies, prohibiting the growing of common barberries. However, the relation of in-

fected common barberries to the life cycle of stem rust was not discovered until 1865 by DeBary. Denmark had many epidemics of black stem rust prior to 1903 when the eradication of the common barberries in that country was begun. Holland, Germany, France, Austria, Italy, England, and other countries have eradicated the barberries in their grain growing districts and controlled stem rust. Investigations in 1920 by the Minister of Agriculture in Wales, where no attempt has been made to eradicate the barberries, showed that over one-half of the farms had barberries, and that about 75 per cent of these were spreading stem rust to grains. On the other hand, in the same latitude in England, where barberries have been eradicated, no stem rust could be found by a member of the United States Department of Agriculture, who spent several months making investigations of black stem rust in Europe in 1922.

The Eradication Campaign in the United States

An eradication campaign was started in April, 1918, by the United States Department of Agriculture in cooperation with the Colleges of Agriculture, the Departments of Agriculture, and other agencies in the 13 north central grain growing states, namely, Colorado, Illinois, Indiana, Iowa, Michigan, Minnesota, Montana, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin and Wyoming. Previous to that time epidemics of black stem rust had caused exceedingly large losses more and more frequently until scientists, many grain growers and others interested, were convinced that this method of control was necessary in order that grain production could be continued in these states. Laws forbidding the propagation of the common barberry and other species and varieties known to spread stem rust soon were passed, or existing laws found adequate in all of these states. The first survey for barberries in all of these states, except in parts of Illinois, Michigan, Ohio and Montana, was completed in 1924.

In addition, a second survey was completed in a number of counties of the barberry eradication area to ascertain if all of the barberries had been removed on the original survey.

Table 3 shows the number of properties and bushes found in the various states and the number of those bushes which were "escaped," that is, found wild in the woods and pastures.

TABLE 3.—DATA SHOWING BY STATES, THE NUMBERS OF PROPERTIES UPON WHICH BARBERRY BUSHES AND ESCAPED BARBERRY BUSHES HAVE BEEN FOUND AND THE NUMBERS OF BUSHES AND ESCAPED BUSHES FOUND, 1918 to 1924, INCLUSIVE.

State	Number of			
	Properties		Bushes found	Bushes escaped from cultivation
	on which barberries were found	having escaped bushes		
Colorado-----	1,706	57	24,350	2,645
Illinois-----	12,223	971	272,551	127,082
Indiana-----	4,674	278	194,780	102,724
Iowa-----	9,562	677	791,876	58,084
Michigan-----	10,177	1,532	466,814	343,633
Minnesota-----	5,018	453	784,224	81,177
Montana-----	258	10	10,192	879
Nebraska-----	3,868	87	94,273	5,683
North Dakota----	835	1	22,145	150
Ohio-----	9,460	319	261,073	29,989
South Dakota-----	1,035	108	59,140	20,727
Wisconsin-----	9,561	1,029	3,372,783	3,080,555
Wyoming-----	88	1	4,142	1
Totals-----	68,465	5,523	6,358,343	3,853,329

In addition to the 6,358,343 original bushes found, 4,607,142 seedlings and 273,619 sprouting bushes have been found. This makes a grand total of 11,239,104 bushes, sprouting bushes and seedlings found, of which 10,634,741 have been destroyed.

The campaign in Wisconsin was begun in April, 1918, by the United States Department of Agriculture in cooperation with the State Department of Agriculture and the College of Agriculture. A law was passed by the legislature in 1919 prohibiting any person from shipping, selling, or permitting any harmful barberry to exist on his premises.

HOW BARBERRIES ARE LOCATED

Inasmuch as barberries have been introduced into this section of the country they are found chiefly in the dooryards, cemeteries, parks, and other places where shrubbery usually is planted. If no bushes are found in these places the adjoining woodlands and fence rows are only casually examined. However, if one or more barberries have been found to be planted

in any of such locations, all territory in the immediate vicinity is surveyed on foot to locate any escaped bushes which may have grown from seeds spread from the planting by birds or other animals. It is necessary to inspect all territory at least two miles beyond the last escaped bush found.

The first survey of the entire state was finished in October, 1924. The cost of the work so far in Wisconsin has been less than 3 cents per acre of small grain grown in a single year. Data

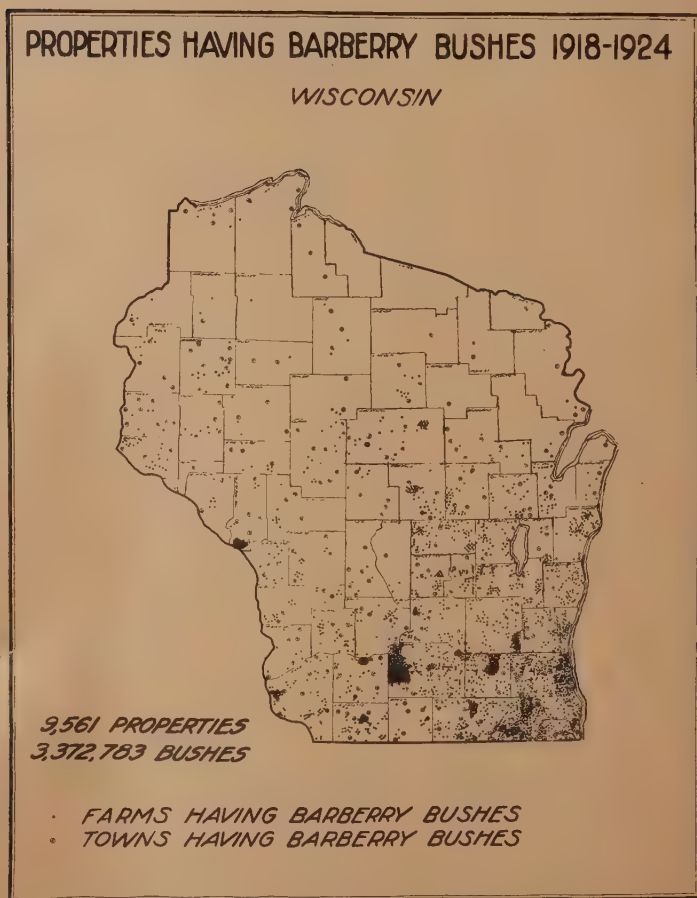


Fig. 1.

showing by counties the acres of small grain grown, numbers of properties upon which bushes were found, with the numbers of planted and escaped bushes, is given in Table 4. The approximate locations of the properties upon which the bushes were found are shown in Figure 7.

TABLE 4—DATA SHOWING, BY COUNTIES, THE ACRES OF SMALL GRAIN PRODUCED IN EACH COUNTY IN THE YEAR THE SURVEY WAS MADE AND THE NUMBER OF BARBERRIES FOUND, FROM APRIL 1, 1918, TO DECEMBER 31, 1924.

County	Acres of small grains*	Number of properties upon which bushes were found	Number of escaped bushes	Total number of planted and escaped bushes	Number of seedlings
Adams.....	42,710	8	7	46	0
Ashland.....	7,154	20	0	102	137
Barron.....	56,894	47	5	570	277
Bayfield.....	10,899	14	0	151	300
Brown.....	61,939	132	85	1,244	1,027
Buffalo.....	78,550	15	0	60	0
Burnett.....	16,112	12	35	198	150
Calumet.....	43,485	45	0	147	8
Chippewa.....	66,190	32	0	504	0
Clark.....	54,202	44	2	324	0
Columbia.....	92,860	161	192	4,002	42
Crawford.....	29,850	22	1	426	0
Dane.....	142,220	971	121,463	132,788	1,133,069
Dodge.....	132,250	220	1,344	2,801	4,915
Door.....	45,931	16	0	72	0
Douglas.....	8,549	27	0	504	302
Dunn.....	84,503	47	1	357	560
Eau Claire.....	70,718	106	0	976	206
Florence.....	2,662	2	0	4	0
Fond du Lac.....	101,486	239	505	2,030	0
Forest.....	3,626	3	0	17	0
Grant.....	83,170	154	1,340,736	1,341,396	920
Green.....	55,792	41	0	305	0
Green Lake.....	47,706	59	14	1,349	506
Iowa.....	57,720	108	1,483	2,173	3,900
Iron.....	1,585	0	0	0	0
Jackson.....	65,960	37	0	222	0
Jefferson.....	65,701	422	2,406	188,803	50,248
Juneau.....	45,680	35	0	184	0
Kenosha.....	31,575	326	45	4,927	0
Kewaunee.....	44,313	25	2	178	10
La Crosse.....	42,100	98	0	1,336	0
Lafayette.....	54,320	93	685	943	990
Langlade.....	14,905	41	0	218	0
Lincoln.....	13,423	89	0	874	2
Manitowoc.....	84,709	158	3,843	5,413	2,264
Marathon.....	80,579	165	57	1,464	43
Marinette.....	23,108	39	136	701	56

TABLE 4—DATA SHOWING, BY COUNTIES, THE ACRES OF SMALL GRAIN PRODUCED IN EACH COUNTY IN THE YEAR THE SURVEY WAS MADE AND THE NUMBER OF BARBERRIES FOUND, FROM APRIL 1, 1918, TO DECEMBER 31, 1924.—Continued.

County	Acres of small grains*	Number of prop- erties up- on which bushes were found	Number of escaped bushes	Total numebr of planted and es- caped bushes	Number of seed- lings
Marquette.....	35,909	55	313	478	173
Milwaukee.....	21,429	1,567	1,737	21,552	963
Monroe.....	63,610	70	51	595	40
Oconto.....	35,975	18	0	159	25
Oneida.....	7,445	18	0	74	0
Outagamie.....	64,725	144	811	1,819	1,200
Ozaukee.....	34,837	110	825	1,892	4,312
Pepin.....	30,320	5	0	83	0
Pierce.....	93,633	40	152	488	100
Polk.....	63,139	26	0	323	0
Portage.....	68,749	94	163	976	240
Price.....	6,389	8	0	35	0
Racine.....	35,478	283	71	2,765	0
Richland.....	33,540	43	608	704	1,000
Rock.....	100,149	468	7,611	12,692	525
Rusk.....	8,041	14	0	74	0
St. Croix.....	122,851	41	0	182	0
Sauk.....	83,290	188	2,904	5,951	150
Sawyer.....	4,753	1	0	2	0
Shawano.....	55,530	33	0	110	3
Sheboygan.....	66,940	238	1,116	4,261	1,320
Taylor.....	13,384	9	2	59	517
Trempealeau.....	91,550	98	1,535,097	1,536,041	4,325
Vernon.....	61,510	30	36	138	0
Vilas.....	2,656	0	0	0	0
Walworth.....	72,278	737	53,619	65,944	6,141
Washburn.....	10,925	4	0	56	0
Washington.....	61,891	81	7	1,120	66
Waukesha.....	63,910	422	783	7,191	0
Waupaca.....	56,218	103	365	914	7
Waushara.....	57,445	115	1,036	2,627	783
Winnebago.....	55,075	367	201	4,726	332
Wood.....	34,620	58	0	943	0
Totals.....	3,583,330	9,561	3,080,555	3,372,783	1,222,154

*Taken from Wisconsin Crop Report of year survey was made.

WISCONSIN HAS MANY ESCAPED BARBERRIES

The rapidity with which escaped or wild barberries have spread from the plantings in Wisconsin, most of which are not more than 50 to 60 years old, has made the progress of barberry eradication very difficult. On the original farm-to-farm survey,

which was completed in Wisconsin in 1924, over 130 places were found where escaped barberries had spread from nearby planted bushes. Wisconsin not only has the largest areas infested with escaped bushes but more escaped bushes have been found in the state than in any other of the states in the eradication area. The largest infested area in the state is in the western part of Dane County in the vicinity of the village of Black Earth, where escaped bushes have been found scattered over an area of more than 100 square miles.

Over one million bushes have been eradicated in each of two much smaller areas, one of which is located in Grant County and the other in Trempealeau County. The original plants in each of these cases were less than 75 years old. These locations were very well adapted for the growth of barberries. A large

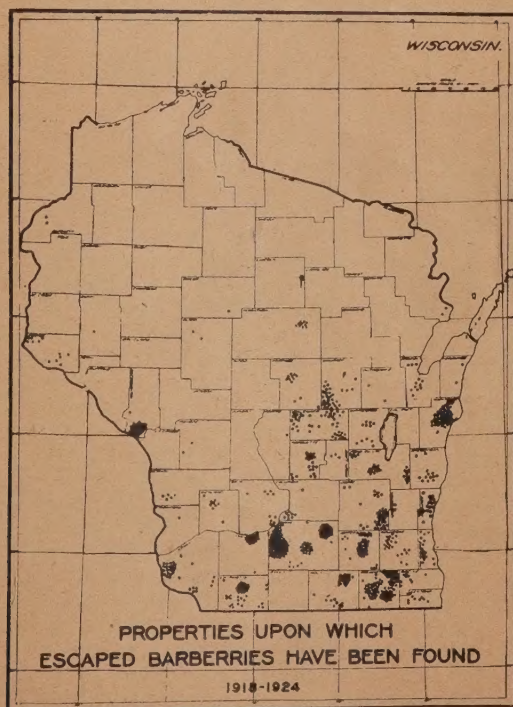


Fig. 8.

percentage of the area is very fertile woodland with hills and limestone bluffs which are not pastured closely, and is practically unmolested from year to year. Nearly all of the escaped bushes have come from seeds carried by birds or cattle from the bushes which were planted in dooryards or hedges. A single large bush may produce several bushels of berries, which, unless disturbed, will remain on the bush the entire winter.

Several species of birds feed upon the berries, especially when the ground is covered with snow, and in most cases the seeds are uninjured. Thus many escaped bushes are found near streams or protected places in bluffs where birds are likely to congregate, or in pastures lightly grazed by cattle. In more intensively cultivated sections where the amount of uncultivated land is small, the escaped bushes are confined to smaller areas. The accompanying map, however, shows that escaped bushes have been found quite generally throughout the state (Fig. 8.)

SALT AND KEROSENE AID IN ERADICATION

Various methods have been used to eradicate the barberries. At first all of the bushes were dug, but it was necessary to find a more efficient and economical method to kill them. The barberry bush has a large shallow root system, spreading a considerable distance from the plant and very close to the surface of the soil. It is practically impossible to dig a bush without leaving many of these roots in the ground, especially when the ground is dry and hard. Roots left in the ground will sprout readily, and even after the most careful digging a dozen or more sprouts from each bush are not at all unusual. After a year's growth these sprouts are found to be more difficult to eradicate than the original bush.

Investigations were begun in 1921 to discover a new method of eradication, and it was found after experimenting with various chemicals that salt, kerosene, or sodium arsenite were effective. Salt has been the most satisfactory from the standpoint of convenience in application and availability. Digging has not been discontinued, however, as many bushes are dug in yards where other shrubbery or trees might be injured by the use of a chemical. It has been possible to use a chemical in almost all cases where the bushes are escaped and in many cases where they are planted. Over 150 tons of salt and 598 gallons of sodium arsenite (a concentrated solution containing the equivalent of 8 pounds of white arsenic per gallon) have been used in Wisconsin to treat over 1,000,000 bushes and seedlings. Over 50 tons of this total quantity of salt were used on bushes and seedlings in the area of escapes near Black Earth, Wisconsin.

Another 20 tons were used in an area at Marshall, Wisconsin. The use of sodium arsenite has been discontinued because of its poisonous nature and inconvenience in handling.

Salt

Ice cream salt or crushed rock salt is the most convenient form of salt to handle, although cattle salt will produce the same results. Ten pounds of salt are sufficient to kill an average sized bush with a 12-inch crown (Fig. 2). The amount may be increased or decreased according to the size of the bush. Where masses of seedlings or a small area of clumps of bushes are to be treated, 2 pounds of salt should be used for each square foot of ground surface. Some large clumps require several hundred pounds, while a small bush of one or two shoots may be killed with as little as 2 pounds of salt. The salt should be piled about the base of the plant so as to surround all shoots. A shoot growing away from the crown must be treated. If there is danger of the salt being disturbed by livestock or poultry, it should be covered with dirt, stones, or brush. Salt is effective at any time during the growing season.

Kerosene

Kerosene is slower in its action in killing barberries than is salt. Where large numbers of bushes are treated with kerosene more bushes will be missed than when salt is used. Salt also serves as a marker and any missed bushes can be distinguished readily by walking through an area after the treatment has been made. However, kerosene is effective and may be used wherever it is readily available and immediate killing is not essential.

The kerosene should be applied to the crown so as to wet the base of each shoot and the ground for 3 or 4 inches around it. One gallon of kerosene is required to kill a barberry bush about 12 inches in diameter. Two quarts is sufficient for a 6-inch crown, and a small shoot will not need more than a pint. When treating an area of clumps or seedlings, one quart for each square foot of ground is necessary. Kerosene treatments are not molested by poultry or livestock as often happens to salt treatments which are not sufficiently covered.

Bushes which are within a few yards of other shrubbery or trees should be dug rather than treated with salt or kerosene. The soil will produce vegetation within two years after either of these chemicals is applied.

MUCH REMAINS TO BE DONE

To complete the barberry eradication campaign in Wisconsin the second survey now in progress must be continued until at least 40 counties in the state are covered even more carefully

than in the first survey. A continuing survey, especially in areas of escaped bushes, is necessary to destroy all sprouts and the seedlings each year for a number of years. The second survey is obviously necessary in all sections which have been intensively settled and where many barberries have been found on the original survey. The results of a second survey in two counties in Wisconsin in 1924 and many counties in other states show that this is necessary, as 8 per cent of the bushes were missed on the first survey.

Although some field men are more efficient than others, it has proved impossible for even the best ones to locate all of the bushes in one survey. Occasionally bushes are cut off by the property owner or renter shortly before the properties are visited. In this case, the location of the planting can only be secured through information from some one acquainted with the property. This is often impossible, especially when the person has forgotten the incident or he is not aware that the bushes cut off were the common barberry. The percentage of bushes missed is reduced to a minimum, however, by thorough general and local publicity, and by making continual observations for stem rust spread on grains which gives clues to the location of bushes.

All properties in the state on which barberries have been found must be inspected for missed bushes, sprouting bushes, and seedlings within two years after the first visit. The areas of escaped bushes will require as many as four, five or more inspections at two-year intervals.

It is not possible to eradicate completely all barberry seedlings for several years after the seeding bushes have been removed. The seeds may lie in the ground two, three, four or more years before germinating, depending on conditions, and in many of the areas of escapes all barberry seedlings can not be detected until they have had several years' growth. For this reason the area of escaped bushes must be inspected often enough to prevent any bushes from becoming large enough to produce seeds, and these inspections must be made over a period of years to get all of the seedlings.

Lastly, it is highly important that all of the people become acquainted with the common barberry in order that the last few bushes may be eradicated. The forces of the United States and State Departments of Agriculture will get most of them, but a few will be missed and can be eradicated only through the co-operation of the public.